Assessment of the Effectiveness of Prelaunch Temperature Testing and Analysis for Unmanned Outer Planet Spacecraft

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In last thirty years, seven unmanned planetary spacecraft have been designed, ground tested and flown to astronomical distances of five (5)astronomical units and beyond. These include two Pioneer spacecraft (Pioneers 10 and 11), Voyagers 1 and 2, Galileo, Ulyssess, and Cassini. These missions include flybys, planetary orbiters, and atmospheric probes. The thermal design approach applied to these spacecraft evolved from the passive thermal designs applied to the earlier Pioneer, Ranger, and Mariner lunar and interplanetary spacecraft. The ground test and analysis programs have also evolved from that heritage. The inflight temperature data from representative sets of engineering subsystems and science instruments from four of these spacecraft are compared to those obtained during the ground test programs and from the prelaunch predictions. Included in the assessment is a description of the technology used in the electronics and of the thermal aspects of the packaging. This information is used to evaluate how strongly evolving technology and packaging influences the ground test and analysis programs for the new generations of outer planet spacecraft and to evaluate the magnitude of temperature excursions observed during duty cycling in flight. Several lessons are presented with specific recommendations for considerations for new projects to aid in the planning of cost effective temperature design, test, and analysis programs.

10/20/00